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AN ANT COLONY APPROACH TO SOLVE A VEHICLE ROUTING PROBLEM IN A FMCG COMPANY

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ABSTRACT

The customers for Fast Moving Consumer Goods [FMCG] are widely spread and often poses challenges for quick delivery of goods. The parameters dealing with the FMCG are logistics cost and time bound delivery of goods. Time slots are the additional constraints which are dealt with this problem. The above problem with the FMCG can be modelled as a Vehicle Routing problem with time slots. In Vehicle routing problems, the vehicle has to cover the entire routes in an optimal manner such that the vehicle visits each and every depot satisfying the customers and also meeting the capacity constraints and customer demands. We have many algorithms to solve the vehicle routing such as GA, Simulated annealing. In this paper, we have adopted ant colony algorithm to find the shortest distance between the various depots.

***KEYWORDS:** Consumer Goods, Vehicle Routing Problem & Various Depots*

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Original Article

INTRODUCTION

(ACO) is very useful for difficult optimization problems, it does not give exact solutions, but near optimal solutions can be found using this algorithm. An artificial ant which is called as software agents will search for good solutions for a given optimization problem. While applying ACO, the given vehicle routing problem results into the problem of finding the best path on a selected tour. The software agents or an ant build solutions incrementally on the graph. Its a probabilistic development process for the solution constructions and it is based on a pheromone model. Pheromone is a substance, which the natural ants secrete along the traversing path and it helps in finding the best or shortest path in reaching the destination.

Ant colony Optimization can be used in solving TSP (Traveling sales Person) problem. The TSP is defined by various cities and its location. The rule of the TSP is that the sales person can visit each city only once. The problem lies in finding the best path of the tour without violating the TSP rule and reaching the destination, it can also be the shortest path to reach the destination.

The vertices of the graph are associated with the touring cities, when we apply ACO to the TSP. This graph is called *construction graph.* The rule of TSP is that we can randomly start from any city and complete the tour and reach back to the starting point. The path of the tour traversed in various cities can be mapped on a graph or plotted on a graph. Each length of the edge on the graph is proportional to the distance the sales person has traversed and accordingly the pheromone values are computed and adjusted on the graph. While applying ant colony algorithm the pheromone values are updated and its represents the cumulative experience of the ant colony

The procedure for ant colony algorithm is as follows. Each ant randomly moves from one city and it probabilistically determines which city to reach. This probabilistic rule is the pheromone content of the ant. The path traversed by the ant is kept in the memory and it avoids the cities which are already visited. The solution is ready once the ant visits all the cities and its pheromone content is updated.

LITERATURE REVIEW

Vehicle Routing Problem (VRP) is a problem where products are transported in one vehicle to different locations [1]. Considerable improvements have been made in this. Capacitated Vehicle Routing Problem (CVRP) is one of the kings of vehicle routing problems and it involves transportation of the goods in vehicles which have a capacity constraint [2].

CVRP have been successfully solved using meta heuristic algorithms, the reason being is quick and give near optimal solution as they ensure low complexity, low computational time and medium accuracy [3]. Although algorithms are available to give us exact solution, in many cases it is inadequate[4]. Some of the affected used algorithms are Clarke and Wright Savings algorithm [5], Sweep Algorithm [6] and the Cluster First and Route Second Fisher and Jaikumar [7] algorithm, Holmes and Parker algorithm [8] and a popular local improvement heuristic is K-Opt Exchange method [9]. In the present work ant colony algorithm is being used to solve a typical vehicle routing problem for a FMCG company. A brief discription about the algorithms is being discussed in the subsequent section.

Ant Colony Algorithm

Ant colony algorithm is one of the meta heuristic algorithms used to solve the combinatorial optimization problems,s tarting from problems of quadratic assignment to vehicle routing problems. Thru ant colony algorithms, near-optimal solutions can be solved for various algorithms like vehicle routing. There is an advantage in using ant colony algorithm in that the graph changes dynamically in real time as compared to genetic algorithm and simulated annealing and other algorithms time. There is a lot of scope for ant colony algorithms, particularly in urban transportation systems and network routing.

The ACO algorithm is a probabilistic algorithm which is based on ants. Based on this rule the ant chooses to move from one city to another. There are certain rules and assumptions framed in applying this algorithm. The rules are:

- Only once the ant must visit the city.
- The probability to choose a distance city is less
- In this algorithm the pheromones are calculated using the probabilistic formulae which is the basis for the ants to select and choose the cities. More the intensity of the pheromone greater is the probability to choose the city.
- Once the shortest path is determined the ant deposits more pheromone along the edges it has traversed. After each iteration the pheromone trail evaporates.

The optimization process of an ant colony is developed from the behavior of real ants. In real life the ants are blind, but they cooperate with other ants and thus it results in a complex behavior. It is this phenomenon exhibited by the ants that results in the shortest path for reaching the destination. The pheromone is a chemical substance which the ants secrete while traversing on the path in search of food. This pheromone is an information system for other ants to follow. More the pheromone content more is the likelihood for other ants to follow. An Artificial ant is randomly placed in each

city and during each iteration the ant chooses to move to another city. A formula prescribed by Dorigo(1997) has been used for our study purpose:

The stochastic formulae by which the artificial ants move from one city(i) to another city(j) is stated as follows.

$$\delta_K(i,j) = \begin{cases} \dfrac{\mu_{ij}^{\alpha} \times Y_{ij}^{\beta}}{\mu_{ig}^{\alpha} \times Y_{ig}^{\beta}} \\ \sum g \in J_k^j \\ 0 \end{cases} \quad (1)$$

where:

$\delta\_(K)(i,j)$

denotes the probability of ant k that will visit city j from i.

$g \in J\_k\hat{}j$

is the set of cities not visited by ant k in city i.

α

represents the pheromone trails relative importance.

β represents the distance between the cities relative importance.

The stochastic formula as stated above in the equation 1represents the existence of the pheromone trail that a city chosen is a function of how the city is near. By tweaking with the α and β parameters, there is a possibility to determine the larger weights. Once the ant exactly visits the city once, pheromone evaporation at the edges is represented from the formula of (Dorigo 1991) we can calculate the pheromone deposits made by the each ant along the edges.

Implementation of Algorithm

A Vehicle routing data for TSP is shown in Table 1. This data, which has been collected for a FMSCG has been tested with ant colony algorithm on MATLAB Version 2016. The distance between the various locations of Bangalore has been recorded in terms of latitude and longitude. In these algorithms, the different results have been displayed taking the various temperature.

Table 1: Distances in Latitude and Longitude for the Various Customers and Depot

Customer No	X-Co-ordinate	Y-Co-ordinate
Depot	40	50
1	45	68
2	45	70
3	42	66
4	42	68
5	42	65
6	40	69
7	40	66
8	38	68
9	38	70
10	35	66

RESULTS

The ant colony algorithm forms better for an ant count of 200. The optimal route for all the 50 customers has been selected. The ACO performs better for 200 ants compared to 100 and 300 ants. The optimum route thru which all the goods can be successfully delivered has been achieved by ACO. The best path of the route obtained at different levels of ants is given in Figure 1-3. Thus the authors want to prove that ACO suits best for vehicle routing problems.

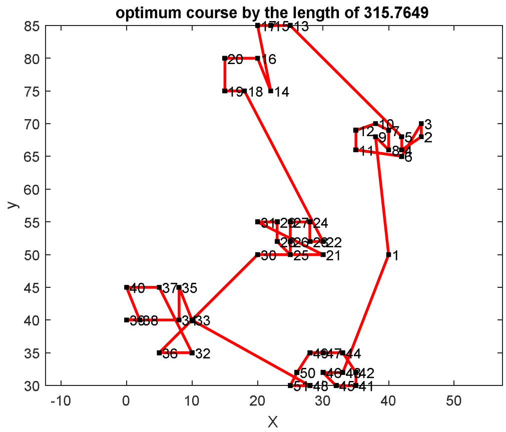

Figure 1: Results of TSP using ACO for 100 Ants

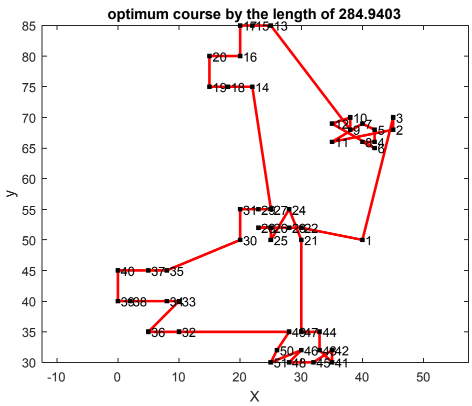

Figure 2: Results of TSP using ACO for 200 Ants

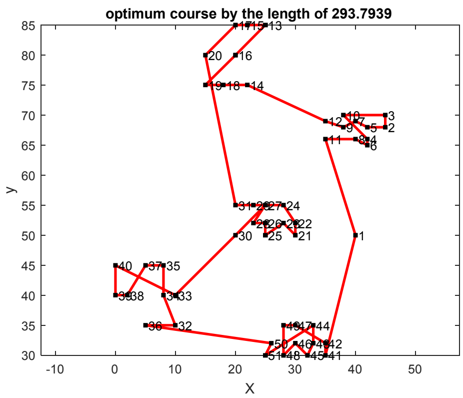

Figure 3: Results of TSP using ACO for 300 Ants

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